REMARKS

Reconsideration and withdrawal of the rejections set forth in the Office Action dated September 30, 2008, is respectfully requested in view of this amendment. By this amendment, claim 22 has been amended. Claims 1-29 are pending in this application.

The amendment to claim 22 changes the the terms "root chord" and "tip chord" to "wing root" and "wing tip", respectively. It is respectfully submitted that the above amendments introduce no new matter within the meaning of 35 U.S.C. §132, and the scope of claim 22 was not altered or reduced by this amendment.

In the outstanding Office Action, the Examiner rejected claim 22 under 35 U.S.C. §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicants regard as the invention. Claims 1, 4, 8, 9, 13-17, 19-21, and 27-29 were rejected under 35 U.S.C. §102(b) as anticipated by Swinson, et al., U.S. Patent No. 5,890,441 (hereinafter *Swinson*). Claims 2, 3, 5, 6, 7, and, 10-12 were rejected under 35 U.S.C. §103(a) as unpatentable over *Swinson*, taken in view of Herrick, U.S. Patent No. 2,699,299 (hereinafter *Herrick*). Claims 18 and 22-26 were rejected under 35 U.S.C. §103(a) as unpatentable over *Swinson*. These rejections, as applied to the revised claims, are respectfully traversed.

Rejections Under 35 U.S.C. §112

The Examiner rejected claim 22 under 35 U.S.C. §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicants regard as the invention. Specifically, the terms, "tip chords" and "root chords" were cited as allegedly unclear.

Response

Reconsideration and withdrawal of the rejection are respectfully requested.

35 U.S.C. §112, second paragraph, states that "[t]he specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention."

It is respectfully submitted that amended claim 22 now presents terminology which clearly sets forth the subject matter, and as such particularly points out and distinctly claims the subject matter. Accordingly, Applicants submit that the rejection of claim 22 under 35 U.S.C. §112 is overcome.

It is therefore respectively submitted that the rejection under 35 U.S.C. 112 should be withdrawn.

Rejections under 35 USC §102 and §103(a)

Claims 1, 4, 8, 9, 13-17, 19-21, and 27-29 were rejected under 35 U.S.C. §102(b) as anticipated by *Swinson*. *Swinson* is also used as the basis for a rejection of Claims 18 and 22-26 under 35 U.S.C. §102(a). *Swinson* is cited as allegedly disclosing:

- a UAV with a non-positive trailing edge sweep, an aft wing with side panels, a tapered planform and control surfaces. The fore and aft wing being disposed at different heights in a tandem close-coupled arrangement.
- a wing planform area that is at least 70% of the total areas of both the wings and area between the wings.
- fore and aft wings with low aspect ratios, where the aft wing has a larger planform area.
- an aft wing with rudder control surfaces on its side panels,
- a tractor propeller, a pushing propeller, and a negative pitching moment at zero lift.
- at least one wing with non-zero dihedral angle.

In addition, *Swinson* is cited as having a fuselage and longitudinal aerodynamic stability.

Response

This rejection is traversed as follows. For a reference to anticipate an invention, all of the elements of that invention must be present in the reference. The test for anticipation under section 102 is whether each and every element as set forth in the claim is found, either expressly or inherently, in a single prior art reference. *Verdegaal Bros. v. Union Oil Co. of California*, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987); MPEP §2131. The identical invention must be shown in as complete detail as is contained in the claim. *Richardson v. Suzuki Motor Co.*, 9 USPQ2d 1913, 1920 (Fed. Cir. 1989); MPEP §2131.

Overview

Mini and micro UAVs are special classes of aircraft. As disclosed in the Background section of the present application, mini-UAV are considered to include vehicles of about 20 cm to 1.2 m size, while micro-UAV are limited to 6 inches (15 cm) in overall span and length according to the definition of the U.S. Defense Advanced Research Project Agency (DARPA).

Conventional design specifications for micro UAV produce a set of conflicting requirements. On the one hand, maximizing the allowable rectangular area of 15cm by 15cm by prior art designs provides low wing loading and increased Reynolds numbers, but on the other hand this results in wing shapes with low aspect ratio, reduced lift carrying capabilities and poor aerodynamic efficiency. Further, the control surfaces of conventional configurations have short moment arms and produce marginal stability and control characteristics, resulting in unsatisfactory flying qualities.

The aerodynamic design of such small aircraft as mini and micro UAVs is not a matter of simply scaling down geometrically the design of larger aircraft. This is mainly due to the low Reynolds number (for example in the order of about $2*10^4$ to about $3*10^5$) in horizontal flight

and the requirement of low speed for such mini and micro UAVs, which is comparable with moderate wing speeds of perhaps about 10 to about 20 m/s.

Thus, for example, if a wing that is designed for large aircraft for a particular Reynolds number is scaled down to 0.25 of its original linear dimensions, the airflow velocity over the scaled down wing has to be ***increased*** by a factor of 4 (= 1/0.25) to obtain similar flow behavior (and similar Reynolds number) as in the original non-scaled wing, so that if the speed is maintained constant, there is inevitably a reduction in Reynolds number for the scaled wing. At the same time, scaling down the linear dimensions by a factor of 4 results in a reduction in wing area of 16 and a reduction in volume (and thus weight) of 64, which leads to lower wing loading and reduction of flight airspeed, and the reduction in airspeed further reduces the Reynolds number of the scaled wing relative to the original wing. Airspeed cannot be increased for the scaled wing as this will require flight at much lower lift coefficients relative to the un-scaled wing, resulting in significant degradation of aerodynamic efficiency.

Thus, scaling down wing dimensions and reducing the airflow velocity results in much lower Reynolds numbers, and thus airflow conditions, with respect to the original wing. In the case of the aforementioned mini and micro UAVs, their linear dimensions *and the flight speeds* are *both* considerably reduced with respect to larger conventional aircraft including conventional UAV, and thus the operating range of Reynolds number is *much less* than for the larger vehicles.

It is also a well-known phenomenon that lift and drag characteristics deteriorate rapidly as Reynolds number is decreased, so that an acceptable performance in a particular aircraft design generally translates to unacceptable performance when the design is scaled down linearly and the design speed of the scaled design is also reduced to a fraction of the design speed of the original design.

Thus, it is respectfully submitted that a skilled artisan recognizes that configurations for aircraft, including UAVs, larger than the aforesaid mini and micro UAVs do not ordinarily apply thereto. It is further respectfully submitted that the references cited do not explicitly disclose or

suggest such mini and micro UAVs, and are therefore not relevant prior art. This will be further elaborated below.

Claim 1 of the present application is directed to:

An aircraft arrangement of self-propelled Mini or Micro UAV comprising a fore wing and an aft wing in tandem close-coupled arrangement, wherein said aft wing has side panels and control surfaces, and tapered planform with positive sweep, said fore wing has non-positive trailing edge sweep, the fore and aft wing being disposed at different height, and said arrangement being free of additional wings or tail arrangement.

As disclosed in the present application, the configuration defined by claim 1 has advantages which are particularly relevant to its application to mini and micro UAVs.

Swinson, et al., U.S. Patent No. 5,890,441

The Examiner has cited *Swinson* for lack of novelty in claims 1, 4, 8, 9, 13-17, 19-21 and 27-29.

The Examiner has also cited the combination of *Swinson* and *Herrick* as rendering obvious claims 2, 3, 5, 6, 7, 10-12.

The Examiner has also cited *Swinson* as rendering obvious claims 18, 22-26.

Swinson discloses a device for programming industry standard autopilots by unskilled pilots. *Swinson* is also directed to providing a horizontal or vertical take off and landing (HOVTOL) flying apparatus employing two vertical lift devices equally and longitudinally spaced from the center of gravity of the apparatus; continuously integrated with a drive train apparatus, optional single or multiple power means; and congruously connected thereto horizontal thrust devices.

While this reference mentions a UAV application, there is no disclosure or suggestion of mini or micro UAV applications as discussed above. In fact, a skilled artisan would consider that this reference actually "teaches away from" such small UAVs -- see for example column 10, lines

43 to 53, where clearly such anticipated non-aviation applications are not suited for small UAV, but rather for relative large aircrafts.

Thus, it is respectfully submitted that this reference is not relevant prior art.

It is also respectfully submitted that even if considered relevant prior art, this reference does not disclose nor suggest the configuration claimed in claim 1 and fails to show each and every feature of the presently claimed subject matter.

By way of example, claim 1 requires the fore wing and an aft wing to be *in tandem close-coupled arrangement*. This close-coupling provides a beneficial airflow interaction between the two wings that enhances the lift, and in geometric terms, in such close-coupled arrangement, the average gap between the trailing edge of the fore wing and the leading edge of the aft wing may be less than the chord of the fore wing root, as disclosed in the specification. In contrast to claim 1, there is absolutely no disclosure or suggestion in *Swinson* of any close coupling. Referring to Fig. 4 of this reference, for example, it is abundantly clear that there is a very large longitudinal spacing between the canard 4 and the wing 1 of the aircraft, much larger than the chord of the fore wing root for example.

In fact, this reference specifically discloses a "canard-and-wing" arrangement (canard design). As is well know in the art, a canard is provided mainly for trimming and for longitudinal stability, though it can also provide a lift contribution to an aircraft, and it is also generally known that it is advantageous to space the canard from the wing as much as possible longitudinally in order to provide a greater moment arm for the canards to facilitate the trimming function. Accordingly, the reference teaches away from close coupling of a fore wing with an aft wing, even if the arrangement of a fore wing and an aft wing were to somehow be considered analogous to a canard-and-wing arrangement.

Claim 1 also requires *the fore and aft wing to be disposed at different heights*. There is absolutely no disclosure nor suggestion in *Swinson* of the canard-and-wing of this reference to be arranged at different heights. Referring to *Swinson*, taking Figs. 1 and 4 together suggests that

the canards and wings are at least generally co-planar, and this is further supported by Fig. 6. There is also no reason for a skilled artisan to infer from this reference that the canards and wings should be at different heights. This is not only a matter of different heights, but also the well-known difference in the basic flight characteristics of a canard design aircraft.

In contrast, the different heights for the fore wing and aft wing of the present application provide a beneficial effect in that induced drag is reduced in a manner similar to that obtained in bi-planes, even though in the present configuration the fore wing is longitudinally displaced significantly with respect to the aft wing. Without being restricted to theory, it is suggested that the close-coupling feature allows the aforesaid beneficial bi-plane effect.

Accordingly, Applicants respectfully submit that *Swinson* does not show each and every feature of the subject matter as claimed in independent claim 1, and thus does not anticipate the claims. As such, reconsideration and withdrawal of this rejection is respectfully requested.

It is therefore respectfully submitted that claim 1 is novel and inventive over this reference, and thus at least for this reason, the dependent claims are also novel and inventive over this reference.

Nevertheless, it is also submitted that at least some of the dependent claims disclose features that are novel per se. For example, referring to claim 8, it is amply clear that the combined plan area of the two wings 1 and the two canards 4 of the cited reference is much less than 70% of the plan area provided by the product of (a) the tip-to-tip width between the two wings 1, and, (b) the axial length between the leading edge of the canard 4 and the trailing edge of the wing 1. In fact, the large degree of de-coupling between the canards and the wings in this reference prevents this figure of 70% from ever being reached, even if the wings and canards were replaced with wings and canards of much larger aspect ratio.

Similarly, the arrangement claimed in each one of claims 22 to 24 is neither disclosed nor suggested by this reference.

It is further respectfully noted that the rejection of claims 2, 3, 5, 6, 7, and, 10-12 under 35 U.S.C. 103(a) states:

> "... At the time of invention, it would have been obvious to one of ordinary skill in the art to combine the UAV of Swinson et al. with the wing position and shape of Herrick. The motivation for doing so would have been to get airflow over the aft wing which wasn't disturbed by the fore wing."

It is respectfully submitted that this statement of motivation for combining the two references clearly recognizes the fact that in *Swinson* the canard is aligned with the wing. Therefore, it must follow that the feature of "*the fore and aft wing to be disposed at different heights*" is ***not*** disclosed by this reference. It is respectfully submitted that the analysis in the outstanding Office Action clearly admits that in *Swinson* the canard is aligned with the wing in such a manner as not to provide the aforesaid beneficial biplane effect, where the airflows over the wings interact to reduce induced drag.

Rejections Under 35 U.S.C. §103

The Examiner rejected claims 2, 3, 5, 6, 7, and, 10-12 under 35 U.S.C. §103(a) as unpatentable over *Swinson*, taken in view of Herrick. Claims 18 and 22-26 were rejected under 35 U.S.C. §103(a) as unpatentable over *Swinson.*

Response

This rejection is traversed as follows. To establish a *prima facie* case of obviousness, the Examiner must establish: (1) some suggestion or motivation to modify the references exists; (2) a reasonable expectation of success; and (3) the prior art references teach or suggest all of the claim limitations. *Amgen, Inc. v. Chugai Pharm. Co.*, 18 USPQ2d 1016, 1023 (Fed. Cir. 1991); *In re Fine,* 5 USPQ2d 1596, 1598 (Fed. Cir. 1988); *In re Wilson*, 165 USPQ 494, 496 (CCPA 1970).

A *prima facie* case of obviousness must also include a showing of the reasons why it would be obvious to modify the references to produce the present invention. *See Dystar Textilfarben GMBH v, C. H. Patrick*, 464 F.3d 1356 (Fed. Cir. 2006). The Examiner bears the initial burden to provide some convincing line of reasoning as to why the artisan would have found the claimed invention to have been obvious in light of the teachings. *Id.* at 1366.

As an initial matter, the second reference, *Herrick*, was published in 1948, decades well before the concept of mini and micro UAVs were discussed and defined. Further, *Herrick* clearly relates to a full scale aircraft and thus a skilled artisan would not be motivated to consider the configurations disclosed there when wishing to improve on mini and micro UAVs.

In addition, there is no motivation whatsoever to combine the two references. *Herrick* relates to an aircraft that is convertible to operate between rotor flight mode and fixed wing mode. An upper wing 34 operates as a rotor in rotor flight mode, and the aircraft further comprises a pusher propeller. On the other hand, *Swinson* "teaches away from" any unenclosed rotors or propellers, see for example column 10, lines 23 to 29. Thus, a skilled artisan would not be motivated to consider *Herrick* when wishing to improve on the *Swinson* disclosure.

The Examiner states that the motivation for combining the two references is to "get the airflow over the aft wing that is not disturbed by the fore wing". Applicants respectfully submit that no such motivation would be apparent to a skilled artisan. In *Herrick*, the stabilizer 30 and elevator 32 provide the trimming function of the canards in *Swinson*, while the rotor 34 has the function of the ducted fans 6 and 7 of *Swinson*. Thus, comparing the two references, a skilled artisan would see that the stabilizer 30, elevator 32 and wings 24 are at the same height in *Herrick*, and would further understand that the rotor 34 has to be on top of the fuselage by virtue of being a helicopter type rotor. The fact that rotor 34 is still there when operating in fixed wing flight is as a consequence of its other rotor mode and *specifically **not*** out of any consideration of disturbance of the airflow over wings 24.

Furthermore, it is to be noted that the aircraft disclosed by *Swinson* is configured for operating in VTOL mode, by using the ducted fans 6 and 7. A skilled artisan would also appreciate that in operating the ducted fans, it could be detrimental to arrange to have the canards, or wings, close to the inlet of the ducted fans, as this would interfere adversely with the suction flow field of the ducted fans. It is therefore not entirely surprising that in this reference the canards and wings are shown at or near the bottom of the fuselage, away from the inlets.

It is further noted that the features described above in connection with the rejection of claims 1, 4, 8, 9, 13-17, 19-21, and 27-29 under 35 U.S.C. §102(b) as anticipated by the *Swinson* reference specifically contradict the present subject matter as claimed. Therefore it would be unobvious to modify *Swinson* to meet the presently claimed features.

Applicants therefore respectfully submit that the *Swinson* reference, taken alone and in combination with *Herrick*, fail to teach or suggest all the features as recited in claims 2, 3, 5, 6, 7, 10-12 18 and 22-26. It is therefore respectively submitted that the rejection under 35 U.S.C. 103(a) should be withdrawn.

CONCLUSION

In light of the foregoing, Applicants submit that the application is in condition for allowance. If the Examiner believes the application is not in condition for allowance, Applicants respectfully request that the Examiner call the undersigned.

Respectfully submitted,
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